3.0 PHOTO ENFORCEMENT EQUIPMENT INSTALLATIONS

Field inspections were also carried out to verify the placement of the photo enforcement equipment and vehicle detection loops at each of the 19 intersections. From these field inspections, special attention was directed to the placement of the vehicle detection loops at each intersection was determined including the length and width of each loop, distances of the loops from the stop line, and the loop-to-loop separation distances or, when measured from center to center, the pitch. The field measurements were compared with the improvement plans prepared when the loops were installed and differences noted. Field measurements for the placement of other photo enforcement equipment were also made and compared against the measurements shown on the intersection improvement plans.

3.1 VERIFICATION METHODOLOGY

The City of San Diego provided copies of the improvement plans for each intersection showing the proposed improvements, showing the proposed locations for the installation of the photo enforcement equipment at each of the 19 intersections. None of the improvement plans were signed and sealed by a Registered California Civil or Electrical Engineer.

Visual inspection and detailed measurements of loop, loop connections, camera and flash unit placement, and photo enforcement signs were conducted at each intersection. Loop detector placement measurements were established on the leading edge of the crosswalk or stop line of the movement monitored. This location is considered to be the point at which a vehicle is within the intersection when the light changes from yellow to red, and consequently, running the red light. The details of loop placement, camera, and flash unit placement are presented on a drawing for each intersection in Appendix A. The drawings show the intersection and locations for the loop detector, camera, flash unit placement, and the photo enforcement signs. The drawings show the loop placement detail as shown in the intersection improvement plans as well as the actual “as installed” dimensions.

3.2 VERIFICATION OF IMPROVEMENT PLANS BY LOCATION

Review of the drawings, compared with the field measurements, finds that the improvements required to operate the system were installed but that the actual placement of the loop detectors varied by location from the placements shown on the improvement plans. The variations are shown on the intersection drawings and are discussed in the following discussions for each intersection.

Generally, details of the field measurements and comparison to the installation plans found several deviations to each plan with the exact placement of the loops and in some cases rerouting of conduits and wiring. Two significant differences were observed in the placement of the camera equipment. At Harbor Drive and 32nd Street, the camera was moved to the center median on the northwest leg of Harbor Drive. At Mission Boulevard and Garnet Avenue, the flash unit is missing.

Field inspections of wiring and loop detectors found them to be generally consistent with that shown in the plans except for rerouting of conduit runs around intersections.

WB El Cajon Boulevard At 43rd Street (1404)

The field conditions show a significant difference between the installed loops and the proposed loops. The installed loops measure 73" x 31" and were placed 30" in front of the limit line.

The proposed loops measure 72" x 30" and were to be placed 12" behind the limit line.

The camera unit is installed in the general vicinity as shown on the plans.

WB Harbor Drive At 32nd Street (1444)

The field conditions show differences between the installed loops and the proposed loops. The installed loops measure 99" x 40" and were placed 48" in front of the limit line.

The proposed loops shown on the plan measure 72" x 30" and were to be placed 12" in front of the limit line.

The camera unit was installed on the Harbor Drive center median on the northwest leg of the intersection. The original plans called for the camera to be installed on the northwest corner of the intersection.

WB Garnet Avenue at Ingraham Avenue (1454)

The field conditions show some differences between the installed loops versus the proposed loops. The installed loops measure 92" x 40" and were placed 35" in front of the limit line. A second set of loops, which appear to be inactive, is located approximately 1-inch in front of the first loop and 11 inches in front of the second loop.

The proposed loops measure 99"" x 40" and are to be placed 48" in front of the limit line.

The camera unit was installed in the general vicinity as shown on the plans.

NB Imperial Avenue At Euclid Avenue (1484)

The field conditions show significant differences between the installed loops and the proposed loops.

The installed loops measure 90" x 40" and were placed skewed to the limit line and range from 12" to 40" in front of the limit line.

The proposed loops measure 99" x 40" and were to be placed 48" in front of the limit line.

The camera unit was installed in the general vicinity as shown on the plans.

WB F Street At 16th Street (1504)

The field conditions show differences between the installed loops and the proposed loops. The installed loops measure 90" x 40" and are placed 36" in front of the limit line.

The proposed loops were shown to be 90" x 40". Placement of the loops in relation to the limit line is not given.

The camera unit was installed in the general vicinity as shown on the plans.

WB A Street At 10th Avenue (1523)

The field conditions show some differences between the installed loops and the proposed loops. The installed loops measure 92.5" x 40" and are placed 60" behind the trailing edge of the limit line.

The proposed loops measure 99" x 40" and were to be placed 12" behind the limit line.

The camera unit and flash units were installed in the general vicinity as shown on the plans.

WB Miramar Road At Camino Ruiz (1534)

The field conditions show differences between the installed loops and the proposed loops. The installed loops measure 90" x 40" and were placed 48" in front of the limit line.

The proposed loops measure 92" x 40" and were to be placed 40" in front of the limit line.

The camera unit and flash unit were installed in the general vicinity as shown on the plans.

SB Mission Boulevard At Garnet Avenue (1542)

The field conditions show differences between the installed loops and the proposed loops. The installed loops measure 90" x 40" and were placed 48" in front of the limit line.

The proposed loops measure 99" x 40" and were to be placed 36" in front of the last traffic signal loops. The traffic signal loops are located at the front edge of the limit line.
The camera unit and flash unit were installed in the general vicinity as shown on the plans. However, the flash unit is presently missing from its mounting.

SB Black Mountain Road At Gemini Avenue (1551)

The field conditions show some differences between the installed loops and the proposed loops. The installed loops measure 90" x 40" and were placed 48" in front of the limit line.

The proposed loops measure 95" x 40" and were to be placed 36" in front of the last traffic signal loop. The traffic signal loop locations cannot be precisely determined because the road has been resurfaced since the loops were installed.

The camera unit and flash unit were installed in the general vicinity as shown on the plans.

EB Mira Mesa Boulevard At Scranton Road (1553)

The field conditions show some differences between the installed loops and the proposed loops. Two (2) sets of loops are cut in the number 1 lane. One (1) loop is 2" closer to the limit line. It is not known which loop is the active loop. The installed loops measure 90" x 40" and were placed 48" in front of the limit line. The two-inch difference will not significantly change the operating conditions.

The proposed loops measure 99" x 40" and were to be placed 36" in front of the last traffic signal loop. The traffic signal loops vary in location. One (1) loop is 24" in front of the limit line while another is 12" in front of the limit line.

The camera unit and flash unit were installed in the general vicinity as shown on the plans.

NB Bernardo Center Drive To WB Rancho Bernardo Road (1414)

The field conditions show some differences between the installed loops and the proposed loops. The installed loops measure 72" x 30" and were placed 32" in front of the limit line.

The proposed loops measure 72" x 30" and were to be placed 12" behind the limit line.

The camera unit was installed in the general vicinity as shown on the plans.

WB Aero Drive At SB Murphy Canyon Road (1422)

The field conditions show differences between the installed loops and the proposed loops. The installed loops measure 72" x 31" and were placed 31" in front of the limit line.

The proposed loops measure 72" x 30" and were to be placed 12" in front of the limit line.

The camera unit was installed in the general vicinity as shown on the plans.

SB College Avenue To Montezuma Road (1462)

The field conditions show differences between the installed loops and the proposed loops. Two (2) loops were cut at the location of the furthest loop from the limit line, which measure a 9" difference. It is not known at this time which loop is active. The installed loops measure 100" x 39" and were placed 50" in front of the limit line.

The proposed loops measure 99" x 40" and were to be placed 48" in front of the limit line.

The camera unit was installed in the general vicinity as shown on the plans.

WB La Jolla Village Drive To Towne Center Drive (1474)

The field conditions show two sets of loops overlapping each other. The active set of loops is not known at this time. The larger set of loops will be referenced as Detail B and the smaller set of loops referenced as Detail C on the intersection drawing. The loops identified as Detail B

measure 99" x 40" and were placed 35.5" in front of the limit line. The loops identified as Detail C measure 72" x 31" and were placed 24" in front of the limit line.

The proposed loops measure 99" x 40" and are to be placed 48" in front of the last traffic signal loops. The traffic signal loop locations cannot be determined due to the fact the road has been resurfaced since the loops were installed.

The camera unit was installed in the general vicinity as shown on the plans.

SB Black Mountain Road To EB Mira Mesa Boulevard (1492)

The field conditions show differences between the installed loops and the proposed loops. Two (2) sets of loops were cut at this location. Field investigations located the operating loops. The installed operating loops measure 90" x 40" and were placed skewed to the limit line. The placement ranges from 30" to 44" from the limit line as shown in the plan.

The proposed loops measure 99" x 40" and were to be placed 48" in front of the last traffic signal loops. The exact location of the traffic signal loops has not been determined due to the fact the road has been resurfaced since the loops were installed.

The camera unit was installed in the general vicinity as shown on the plans.

NB Garnet Avenue To NB Mission Bay Drive (1513)

The field conditions show some differences between the installed loops versus the proposed loops. The installed loops measure 90" x 40" and were placed 36" in front of the limit line.

The proposed loops measure 99" x 40" and were to be placed 48" in front of the last traffic signal loop. The existing traffic signal loop locations cannot be determined due to the fact the road has been resurfaced since the installation of the traffic signal loops.

The camera unit and flash units are installed in the general vicinity as shown on the plans.

SB Harbor Drive To EB Grape Street (1533)

The field conditions show a significant difference between the installed loops and the proposed loops. The installed loops measure 90' x 40" and were placed skewed to the limit line and range from 11" to 45" in front of the limit line. The precise dimensions are shown in the intersection drawing.

The proposed loops measure 99" x 40" and were to be placed 35" in front of the last traffic signal loop. One signal loop is located at the front of the limit line while the other is located at the back of the limit line.

The camera unit and flash unit were installed in the general vicinity as shown on the plans.

NB Mission Bay Drive To WB Grand Avenue (1541)

The field conditions show some differences between the actual loops versus the proposed loops. The installed loops measure 90" x 40" and were placed skewed to the limit line and range from 44" to 50.5" in front of the limit line. The precise dimensions are shown in the intersection drawing.

The proposed loops measure 90" x 40" and were to be placed 36" in front of the limit line

The camera unit and flash unit were installed in the general vicinity as shown on the plans.

EB Carmel Mountain Road To NB Rancho Carmel Drive (1543)

The field conditions show some differences between the installed loops versus the proposed loops. The installed loops measure 98" x 40" and were placed 28" in front of the limit line.

The proposed loops measure 99" x 40" and were to be placed 40" in front of the last traffic signal loop. The traffic signal loop locations have not been determined due to the fact the road has been resurfaced since the loops were installed.

The camera unit and flash unit are installed in the general vicinity as shown on the plans.

3.3 WARNING SIGNS

All photo-enforced intersections are signed as required by the California Vehicle Code. The signs have been installed for each intersection approach at, but not of in advance of, the photo-enforced intersections. Typically, the signs are installed on the photo-enforced approaches only.

3.4 LOOP PLACEMENT MEASUREMENTS

A key measurement for the Red Light Camera Program is the center-to-center distance between the loops in each lane, that is, the pitch measurement. A second critical measurement is the distance from the stop line to the leading edge of the second vehicle detection loop. These measurements are especially important for the San Diego system since vehicle speeds based on the pitch measurement are used to estimate the time when motorists actually entered the intersection.

Table 3-1 presents the field measurements of the pitch and distance from the stop line to the leading edge of the first vehicle detector for each intersection. Note that the distance used to compute the speed that vehicles enter the intersection is the distance from the stop line to the leading edge of the second loop.

Table 3-1
CAMERA LOOP PLACEMENT MEASUREMENTS

Code	Location	Camera Pitch (cm)	Distance From Limit Line to Loop Detector (a)
1404	WB El Cajon Boulevard at 43rd Street	201	30”/76 cm
1444	WB Harbor Drive at 32nd Street	225/230 (d)	48”/122 cm
1454	WB Garnet Avenue at Ingraham Avenue	201	35”/89 cm
1484	WB Imperial Avenue at Euclid Avenue	229	12“ to 40”/ 30 cm to 102 cm (c)
1504	WB F Street at 10th Street	203	36”/91 cm
1523	EB A Street at 10th Avenue	204.5	60” /152 cm (e)
1534	WB Miramar Road at Camino Ruiz	202	48”/122 cm
1542	SB Mission Boulevard at Garnet Avenue	205	48”/122 cm
1551	SB Black Mountain Road at Gemini Avenue	203	48”/122 cm
1553	EB Mira Mesa Boulevard at Scranton Road	218.5	48”/122 cm
1414	NB Bernardo Center Drive to WB Rancho Bernardo Road	223	32”/81 cm
1422	WB Aero Drive to SB Murphy Canyon Road	199.5	31”/79 cm
1462	SB College Avenue to EB Montezuma Road	230/235 (b)	50”/127 cm
1474	WB La Jolla Village Drive at Towne Center Drive	200/231 (b)	31.5” to 40.5”/ 79 cm to 103 cm (b)
1492	SB Black Mountain Road to Mira Mesa Boulevard	203	30” to 44” / 76 cm to 112 cm (c)
1513	EB Garnet Avenue to NB Mission Bay Drive	225	36”/91 cm
1533	North SB Harbor Drive to EB Grape Street	203	11” to 45” / 28 cm to 114 cm (c)
1541	NB Mission Bay Drive to WB Grand Avenue	203	44” to 50.5” / 112 cm to 128 cm (c)
1543	EB Carmel Mountain Road to NB Rancho Carmel Drive	203	28”/71 cm

NOTES: (a) Distance from leading edge of first loop to limit line.
(b) Set or sets of overlapping loops, active loops not shown.
(c) Loops skewed at limit line
(d) Two (2) sets of loops
(e) Loops are installed upstream of the limit line.

3.5 VEHICLE DETECTION RELATED ERRORS

As already noted, the vehicle detection loops used to determine vehicle speeds and trigger the photo enforcement cameras have been installed downstream of the point of violation at all but one of the photo-enforced intersections. When situated upstream of the stop line in accordance with the manufacturer’s recommended configuration, the first photograph will clearly show the vehicle before it has entered the intersection on the red traffic signal so that there is no uncertainty regarding the nature of the violation. If the first photograph does not clearly show that the vehicle has not entered the intersection, it may be determined from an examination of the photograph not to cite the motorist.

With the loops situated on the downstream side of the point of violation, the time that the vehicle entered the intersection and its speed at that point is estimated based on the vehicle speed when it traverses the photo enforcement loops. This configuration introduces the possibility that errors in the vehicle speed estimates may result in motorists being improperly cited. This section presents a review of the possible errors that could occur from the use of loops to estimate vehicle speeds and the loop placement at the photo-enforced intersections.

A number of loop detection related errors are possible. Certain errors could be caused by the operation of the loops themselves; other errors could result from the placement of the loops.

The loops installed in the photo enforcement intersections of San Diego are typically rectangular shaped. A loop detector senses a vehicle when parts of the vehicle that have ferromagnetic properties (engine block, front axle) disturb the magnetic flux of the loop in the pavement, changing the resonant frequency of the loop circuit. Typically, the magnetic field created by a rectangular loop will extend above the outside perimeter of the loop, to a height of approximately two-thirds of the width of the loop (about two feet for a 40-inch loop width). The magnetic field also spills outside of the loop perimeter at a height of a few inches above the pavement surface to a distance of about one-half of the loop width (about 20 inches for a 40-inch loop). This spillover effect can result in two adjacent loops interacting with each other (referred to as crosstalk), causing false detects and frequently resulting in the detectors locking up in detect mode. The change in the resonant frequency of the loop circuit is measured by the loop detector electronics and, when greater than a pre-determined amount, is recognized as a vehicle detect. By its nature and method of operation, loop detectors do not provide pinpoint accuracy and consistency in the point of the loop where detection is actuated. These characteristics can result in possible errors.

Followings are the examples of such errors that can occur when a motor vehicle is detected by loops.

3.5.1 Long Pitch Error

Figure 3-1 illustrates a possible error condition where a vehicle is detected on the leading edge of the first loop and on the trailing edge of the second loop.. In Note that this error condition is possible but is not likely as evaluated this instance, the vehicle actually travels a distance of 120 inches, from the first loop to the second loop, but the camera unit calculates the vehicle speed based on a pitch measurement of 80 inches. This error results in the vehicle speed being underestimated.

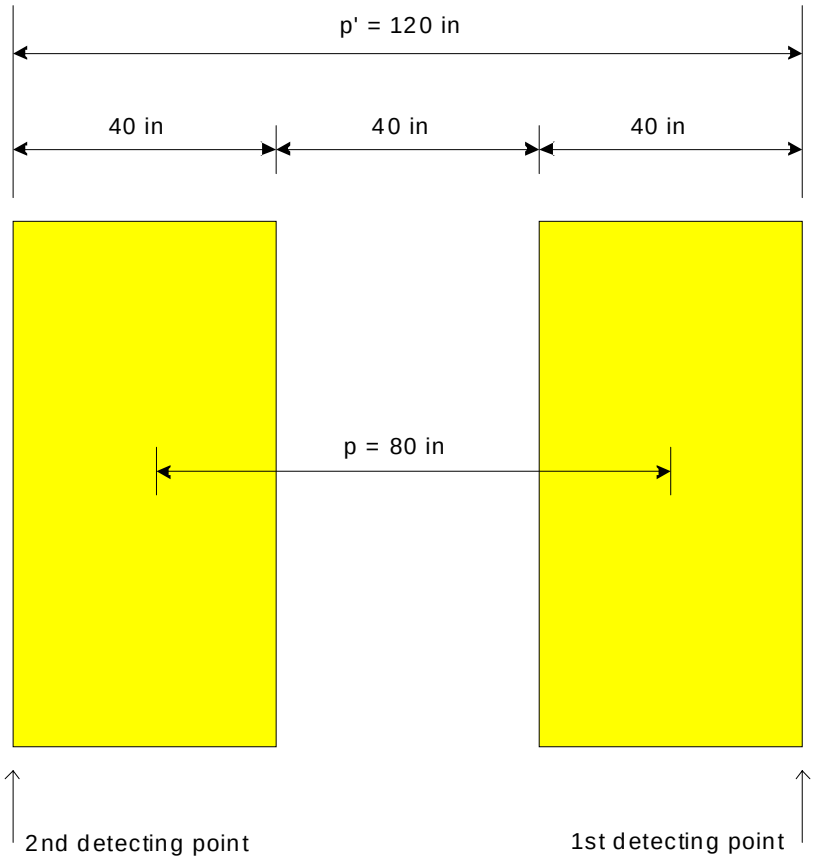

Figure 3-1
LONG PITCH LENGTH ERROR

In this case, the travel time from the first loop to the second loop is:

$$t_{est} = \frac{p'}{p} \times t_{true} \quad (1)$$

The estimated speed, v_{est}, can be computed as follows;

$$v_{est} = \frac{p}{t_{est}} = \frac{p}{\frac{p'}{p} t_{true}} = \frac{p}{p'} \times v_{true} \quad (2)$$

Since p is 80 inches and p' is 120 inches under the typical loop alignment conditions, equation 2 can be rewritten as follows:

$$v_{est} = 0.67 \times v_{true} \quad (3)$$

Equation 3 indicates that the estimated speed will underestimate the true speed by 33 percent. For vehicles where the speed is incorrectly calculated at less than the minimum speed

threshold, the camera will not be triggered and no violation will be recorded. For vehicles where the speed is calculated at more than the minimum speed threshold, the estimated time that the vehicle entered the intersection will be miscalculated as earlier than the actual time. Both of these errors result in motorists who ran a red light not being photographed or, in other words, the possible error condition is in the motorists' favor and cannot result in motorists being improperly cited.

3.5.2 Short Pitch Error

Figure 3-2 illustrates a possible error condition where a vehicle is detected on the trailing edge of the first loop and at the center of the second loop. In this instance, the vehicle actually travels a distance of 60 inches, from the first loop to the second loop, but the camera unit calculates the vehicle speed based on a pitch measurement of 80 inches. This error results in the vehicle speed being overestimated.

Since p is 80 inches and p' is 60 inches, equation 2 can be rewritten as follows:

$$v_{est} = 1.33 \times v_{true} \qquad (4)$$

Equation 4 indicates that the estimated speed will be higher the true speed by 33 percent. For vehicles where the speed is incorrectly calculated at more than the minimum speed threshold, the camera will be triggered and a violation will be recorded. For all vehicle photographed, the estimated time that the vehicle entered the intersection will be miscalculated as later than the actual time.

In the worst case of a vehicle actually traveling at 11.6 miles per hour (estimated speed calculated to be 15 miles per hour), the estimated time that the vehicle entered the intersection will be calculated in error by approximately 0.14 seconds. For a vehicle actually traveling at 30 miles per hour, the magnitude of the error would be approximately 0.06 seconds. The magnitude of this error is less than that the length of the minimum grace periods being used and, consequently, would not result in motorists being improperly cited.

It is possible that a vehicle could be detected on the trailing edge of the first loop and at the leading edge of the second loop, meaning that the vehicle has only traversed a distance of 40 inches and that the vehicle speed would be overestimated by 100 percent. With errors of this magnitude, it is possible that motorists could be improperly cited. However, given that the vehicle detection loops are configured the same, this possible error condition is considered to be extreme and not applicable for this analysis.

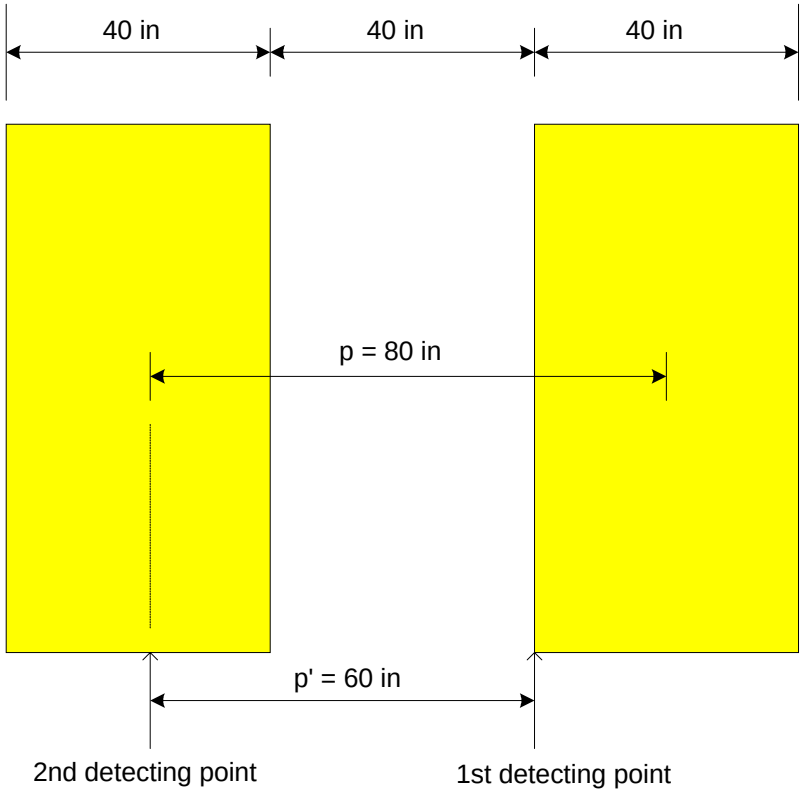

Figure 3-2
SHORT PITCH LENGTH ERROR

3.5.3 Cosine Error

Errors referred to as cosine errors may occur when a vehicle passes the loops with an angle against the loop alignment axis as illustrated in Figure 3-3.

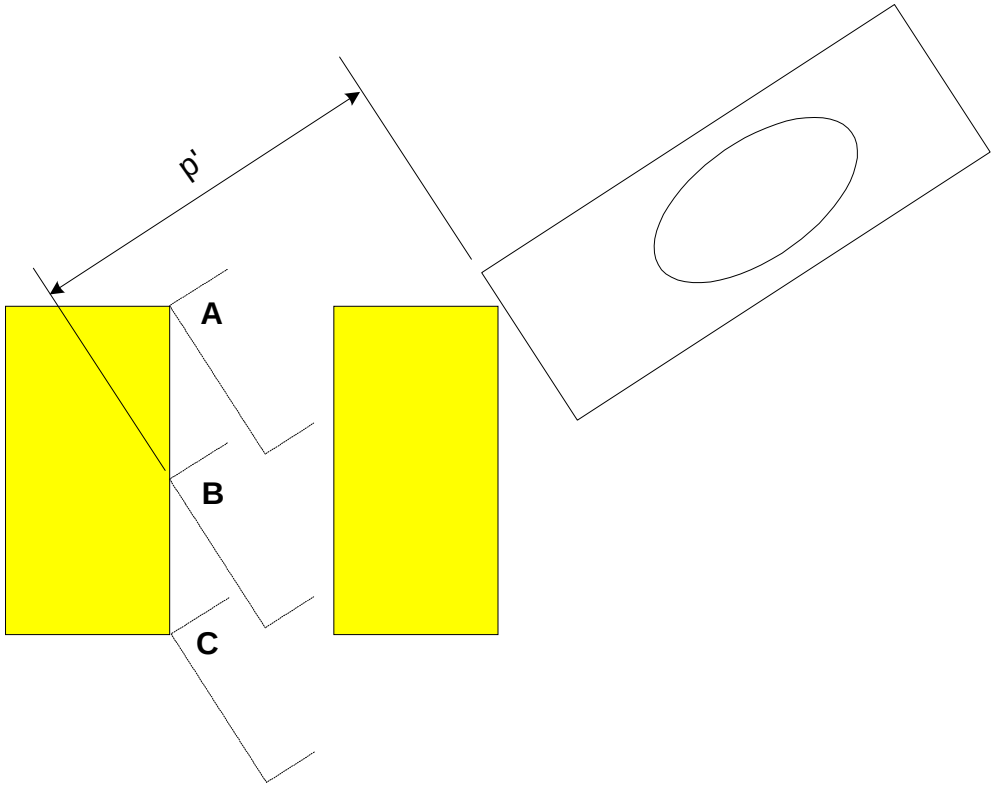

Figure 3-3
EXAMPLES OF POSSIBLE COSINE ERRORS

The actual pitch length (p') depends on the detecting point of the second loop (points A, B, or C in Figure 3-3). The minimum pitch length (p') occurs when the vehicle meets the second loop at point A while the maximum pitch length (p") occurs when the vehicle is detected at point C of the second loop as illustrated in Figure 3-3.

p' and p" can be computed from the geometric configuration as shown on Figure 3-4:

$$p' = \sqrt{40^2 + 45^2} = 60.2 \quad (5)$$

$$p'' = \sqrt{80^2 + 90^2} = 120.4 \quad (6)$$

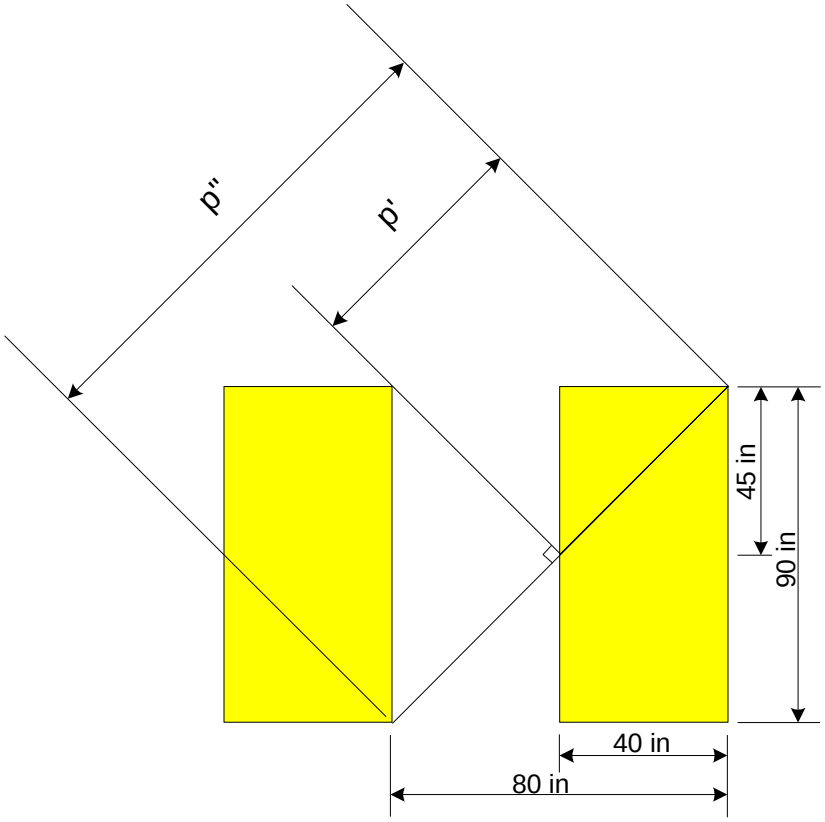

Figure 3-4
MINIMUM AND MAXIMUM PITCH LENGTHS OF COSINE ERROR

From Equations 2, 5, and 6, the relationships between the true speed and the estimated speeds can be obtained as follows:

$$v'_{est} = \frac{p}{p'} \times v_{true} = 1.33 v_{true} \qquad (7)$$

$$v''_{est} = \frac{p}{p''} \times v_{true} = 0.67 v_{true} \qquad (8)$$

When the speed is estimated with the minimum pitch length p', it is overestimated by 33 percent due to the underestimated travel time between the loops. Where the speed is incorrectly calculated at more than the minimum speed threshold, the camera will be triggered and a violation will be recorded although the vehicles actual speed was less than the threshold.

For all vehicles photographed, the estimated time that the vehicle entered the intersection will be miscalculated as later than the actual time. The magnitude of this error is the same as

calculated for the short pitch length error, up to about 0.14 seconds, and is smaller than the grace time periods. Consequently, this error would not result in motorists being improperly cited.

When the vehicle speed is estimated with the maximum pitch length, it will be underestimated by 34 percent due to the overestimated travel time between the loops. In this case, motorists who might be cited based on their actual vehicle speeds will not be photographed. The error is in the motorists' favor and motorists will not be improperly cited.

3.5.4 Errors Due to Acceleration Between Stop Bar and Second Loop

Most of the photo enforcement loops are located on the downstream side of the stop bar. The distances between stop bar and leading edge of the second loop, which may be considered to be the triggering loop, range from between 8.5 feet and 12.1 feet. The distance may be sufficient for some vehicles to change their speed from below the minimum threshold speed, say 15 mph, to above it.

Acceleration performance of a passenger car can reach up to 9.3 ft/sec^2 (ITE Traffic Engineering Handbook). Table 3-2 illustrates the relationship between the starting speed at the stop bar and distance needed to achieve 15 mph at an acceleration rate of 9.3 ft/sec^2.

Table 3-2
MINIMUM DISTANCE FOR SPEEDING UP TO 15 MPH (A = 9.3 FT/SEC^2)

Starting Speed at Stop Bar (mph)	10.2	11.6	12.3	12.8	13.0	13.6	14.3
Distance from Stop Bar (feet)	13.9	10.5	8.6	7.0	6.6	4.5	2.3

It is shown in the Table 3-2 that, when the starting speed on the stop bar is more than 12.8 mph, a vehicle can traverse the second loop with a speed of 15 mph or faster and, thus, may be cited although their approaching speed is slower than 15 mph. For the computation, it was assumed that the average distance between stop bar and second loop is 10.5 feet.

In this case, the vehicle speed is being overestimated by up to about 15 percent for the worst case of the starting speed at the stop bar being 12.8 miles per hour. This error results in the time that the vehicle entered the intersection being later than the actual time by up not more than 0.1 seconds which less than the amount of the grace times being applied and, therefore, would not result in motorists being improperly cited for a red light running violation.

3.5.5 Errors Due to Deceleration Between Stop Bar and Second Loop

In this case, the vehicle speed from the first loop to the second loop will be slower than the actual speed and any errors will be in the motorists' favor. No motorists will be improperly cited as the result of this error condition.

3.5.6 Examples for the Worst Case Errors

Combinations of the short pitch length error, cosine error, and vehicle speeding up error at the same time have not been analyzed. The worst cases may be possible when two different types of speed estimation errors have occurred simultaneously. For example, a vehicle's approaching speed can be overestimated due to the acceleration between stop bar and second loop and, at the same time, the speed can be overestimated again by up to one-third due to the vehicle traversing the loops at an angle. For locations where left turns are being enforced, this particular combination is clearly one that is possible although it appears that the combined error is generally less than provided by the grace times.

For all possible error conditions or combinations of error conditions where vehicle speeds are overestimated, it is apparent that the minimum speed thresholds are not being applied on a consistent basis and that the actual grace periods may be less than planned when errors are being covered but it may also be concluded that motorists are not being improperly cited for red light running violations.

3.6 FINDINGS AND RECOMMENDATIONS FOR PHOTO ENFORCEMENT EQUIPMENT INSTALLATION

- Generally at all locations, the “as built” placement of the photo enforcement system improvements do not correspond with the intersection improvement plans, especially with regard to the placement of the vehicle detection loops. At most locations, the “as built” camera pole locations were found to be reasonably consistent with the intersection improvement plans.

  It is an important finding that the intersection improvement plans were not prepared by a California Registered Civil or Electrical Engineer and were not subject to the City’s plan check, permitting, and inspection procedures. Related to this finding, “as built” plans were not prepared for any of the 19 photo-enforced intersections.

  It is an important recommendation of this interim report that the City should require that any further photo enforcement system installations be done in accordance with the City’s plan check, permitting, and inspection procedures; that the intersection improvement plans be prepared by a California Registered Engineer; and that “as built” plans be prepared and then maintained to reflect any subsequent upgrades or adjustments.

- It is a general recommendation, the most important one of the project report, that the City not re-start its photo enforcement program without the relocation of the vehicle detection loops to locations where the first photograph is taken immediately before the vehicle crosses the stop line, instead of after the vehicle has already entered the intersection. This approach will eliminate the uncertainties associated with the measurement of vehicle speeds using the vehicle detection loop pairs.

  The implementation of this recommendation will require that the vehicle detection loops are re-cut and that camera unit settings be adjusted at 18 intersections. Vehicle detection required for the operation of the traffic signals may also need to be installed at

selected locations. At these locations, it is recommended that video-based vehicle detection systems be employed for traffic signal control purposes.

The estimated cost for re-cutting the photo enforcement loops and for installing video detection equipment at 18 intersections is $220,000.

- In conjunction with the relocation of the vehicle detection loops, it is recommended that enhanced advanced warning signs be installed at each intersection to supplement the standard photo enforcement signs currently installed at the photo-enforced intersections. Figure 3-5 shows the advance warning sign currently used by the City of Ventura. This sign could be employed at the City's photo enforced intersections.

  The estimated cost for the purchase and installation of the enhanced advance warning signs for the 19 photo-enforced approaches is $3,800, assuming that the signs can be installed on existing poles.

Figure 3-5
PHOTO ENFORCEMENT ENHANCED ADVANCE WARNING SIGN

- The vehicle detection loop configuration employed at 18 of the 19 photo-enforced intersections requires that the time when motorists entered the intersection against a red light is estimated based on the measured speed over the vehicle detection loops. Errors in the estimated vehicle speeds may result from this configuration as well as from the inherent operating characteristics of inductive vehicle detection loops.

  The possible errors resulting from the loop configuration and loop operating characteristics have been analyzed. From the analysis, it appears that the grace periods being applied before citations are issued are sufficiently long to compensate for any errors and that the City should be confident that all citations issued to date under the photo enforcement program have been properly issued with regard to possible errors resulting from the configuration of the vehicle detection loops.